Space Weather Technical Forecast

Issued on Thursday, 23 February 2023 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2/Minor-Moderate radio blackouts) likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate with three low M-class flares in the last 24 hours. There are now five sunspot regions on the visible disc. AR3234 is the largest spot, now with a large delta region in the compact centre portion. AR3230 in the southeast is the second largest region, now also with a delta spot. AR3229 in the north near the central meridian is currently of modest size, fading and now a simpler beta configuration. AR3231 is becoming difficult to see as it approaches the western limb. The new spot between AR3229 and AR323 has continued to develop, now with a delta configuration on it's trailing portion and seems to be growing.

Currently no significant Earth-directed CMEs are forecast, although glancing impacts may occur on Thursday and Saturday.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, were indicative of the arrival of the High Speed Stream (HSS) from CH77/+. The wind speed increased from 450-550 km/s between 22/2330-23/0200 UTC. The density, which was initially average, rose to above average after 23/1700 UTC, with a peak of 16ppcc at 22/2337 UTC. The IMF has been at mostly Moderate levels, peaking at 12nT at 22/2332 UTC. The north-south component, Bz, followed a steady weak negative trend until 22/1900 UTC, after which it varied sporadically between +8/-10 nT. The phi angle was mainly away from the Sun (positive), with some negative (toward the sun) periods between 22/1900-23/0600 UTC. Geomagnetic activity was mainly Quiet to Unsettled (Kp 2-3), with one Active interval (Kp 4) between 23/0000-0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was at mostly background levels. The associated 24-hour electron fluence has been well below the Active (1e8 integrated pfu) threshold, reaching 3.56e6 integrated pfu at 23/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is likely to continue, with a slight chance of High activity. The most likely regions to flare are AR3234, AR3230 and the new region in the northeast, all of which should be present throughout the coming four days.

Solar Wind / Geomagnetic Activity: There are two low confidence CMEs in the forecast, one perhaps arriving on the 23rd and another on the 25th. Otherwise, Earth is experiencing a HSS from CH77/+, but this is likely to have only minor impacts and should gradually wane through 23 Feb. A further coronal hole, CH78/-, is located well south on the visible disc but may give Earth a HSS during 25 Feb with winds perhaps reaching elevated levels.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a chance of active intervals throughout, and a slight chance of G1/Minor Storms on 25 Feb due to a combination of

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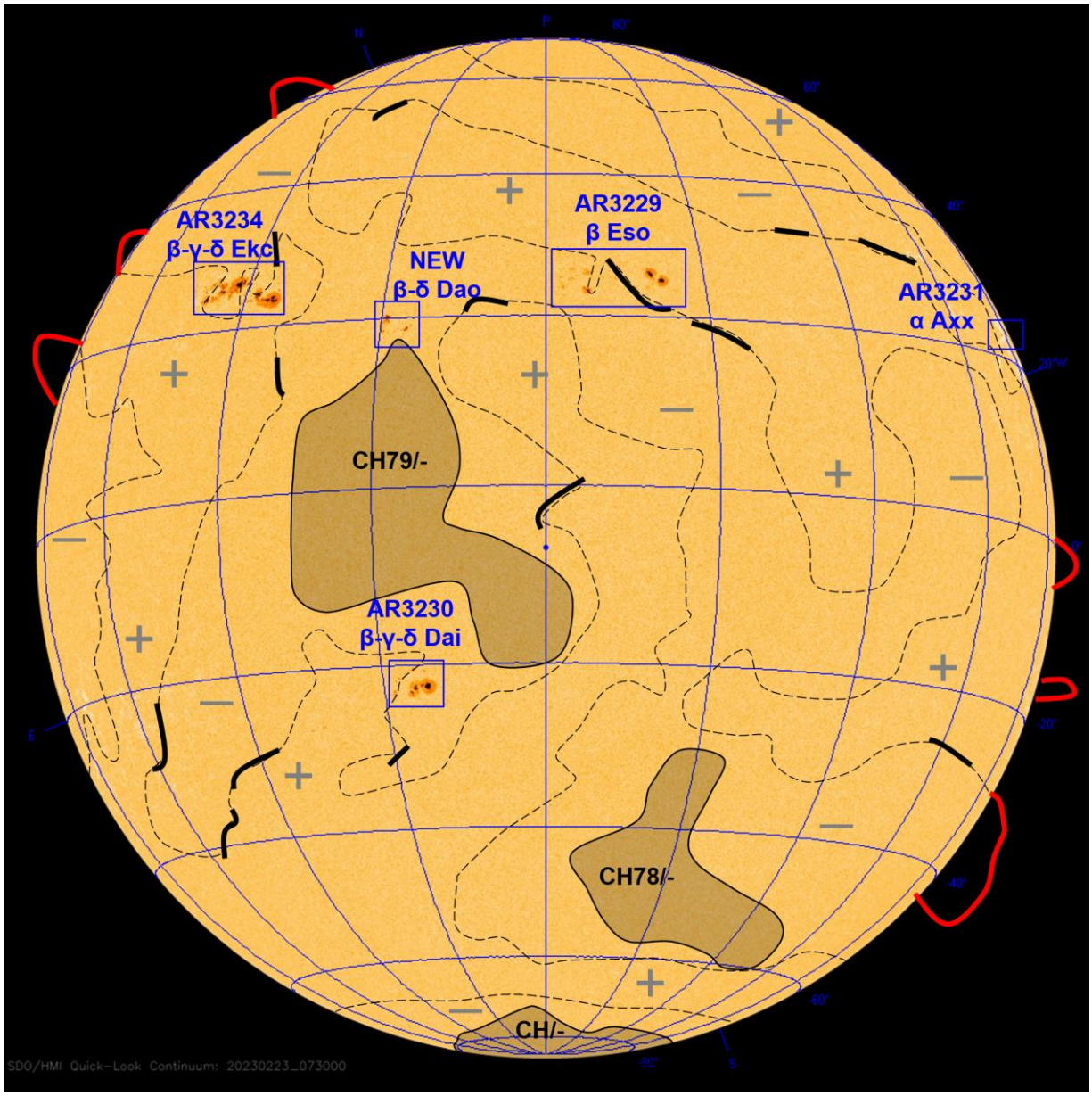
HSS and CME glancing blows.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at Background levels, but with a Slight Chance of rising towards the S1 level. High energy (greater than 2 MeV) electron flux may increase later in the forecast period, however this is low confidence. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu), perhaps rising on 26 Feb.

Figure 1. Solar Analysis Valid 23/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

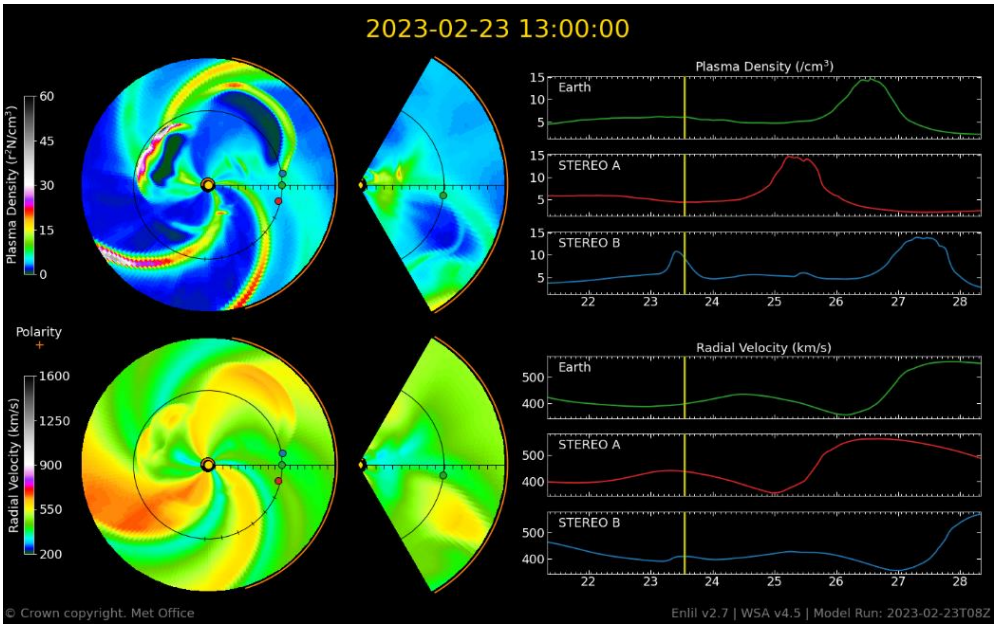
There are two low confidence CMEs in the forecast - one which left the southwest quadrant as a prominence eruption on 19 February, although any influence should be from the shock only and even this is low confidence. This may give a glancing blow on 23 Feb. A second glancing blow from a CME is possible on 25 Feb, from a CME that left the Sun from the northwest on 21 Feb, but most of this should pass above Earth.

Otherwise, Earth is experiencing a HSS from CH77/+, but this is likely to have only minor impacts and should gradually wane through 23 Feb. A further coronal hole, CH78/-, is located well south on the visible disc but may give Earth a HSS during 25 Feb with winds perhaps reaching elevated levels. This is a non-persistent feature so no information is available from the previous rotation, and the timing is therefore low confidence with the arrival possible between late 24 Feb until 26 Feb. This being a negative polarity coronal hole, it is more favoured for a geomagnetic response now we are approaching the March equinox.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a chance of active intervals throughout, and a slight chance of G1/Minor Storms on 25 Feb due to a combination of HSS and CME glancing blows.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



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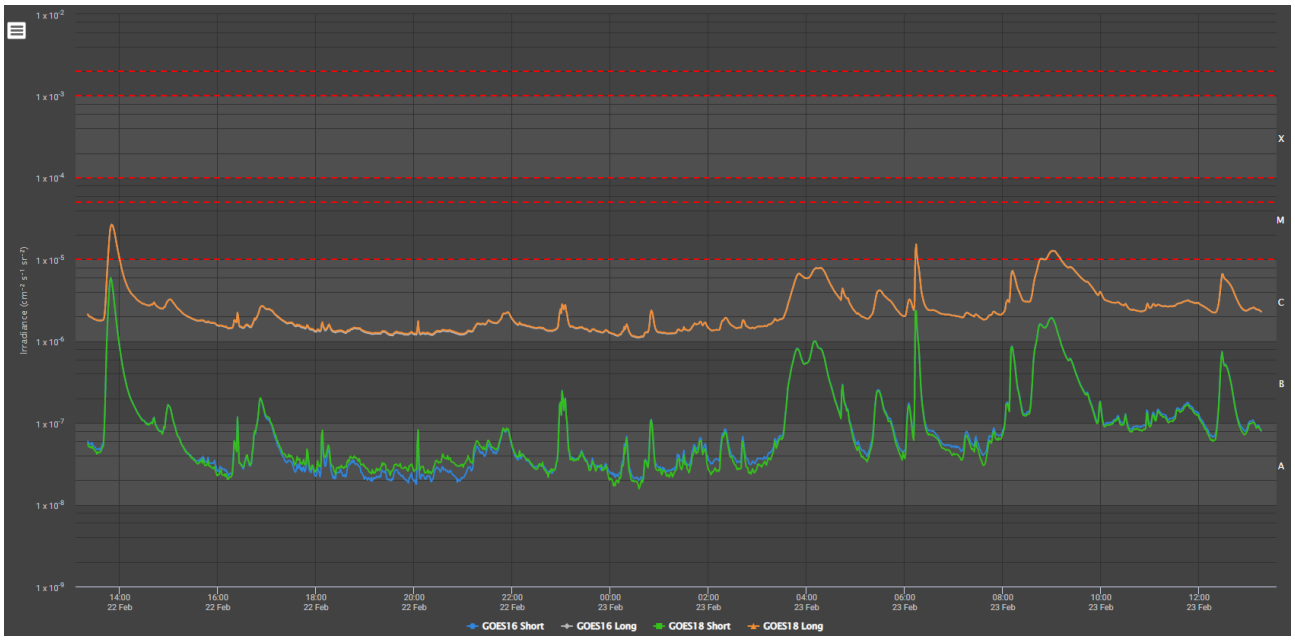
Radio Blackouts - X-Ray Flares:

Solar activity is Moderate with three low level M-flares in the past 24 hours, originating from AR3234, AR3220, and the new region in the northeast, it is likely to remain at this level. There is a slight chance of High solar activity with any isolated X-class flaring, primarily from AR3234, though confidence wanes with time due to possible changes to the aforementioned spots.

There are now five sunspot regions on the visible disc. AR3234 is the largest spot, now with a large delta region in the compact centre portion. AR3230 in the southeast is the second largest region, now also with a delta spot. AR3229 in the north near the central meridian is currently of modest size, fading and now a simpler beta configuration. AR3231 is becoming difficult to see as it approaches the western limb. A new spot has formed recently between AR3229 and AR3234, this spot had developed a delta configuration on it's trailing portion and seems to be growing quickly.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	60	60
Very Active	R3 to R5 X Class	No	15	15	10	10

Figure 3: X-Ray flare trace past 24 hours



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at Background levels.

While there have been no notable enhancements to the high energy proton spectrum in the past UTC week, this is perhaps largely because the larger X-ray events have been limited to the eastern solar hemisphere. The risk of S1 storms through the week remains similar as the waning confidence of current active regions is counteracted by these regions rotating into a more favourable position.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed at GOES16 is now at mostly background levels. There may now be some influence in the solar wind from CH77, although it is minor, with STEREO suggesting this is likely to decline during 23 Feb. As such, significant electron charging from this feature is considered unlikely. It is possible that a more significant HSS from CH78 may arrive on 25 Feb, with the timing low confidence. This may give more significant charging, but with any effects unlikely to be felt until the end of the period. This is a non-persistent feature, so recurrence is not a helpful forecasting guide here. There is the possibility of a couple of glancing CME blows on 23 Feb and 25 Feb, but these are more likely to miss Earth.

The associated fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of the period, perhaps rising on 26 Feb, with a slight chance of exceeding Active. MOSWOC REFM keeps a below Active trend for the next three days, which seems reasonable. With CH78 a non-persistent feature, REFM won't be taking account of this until any HSS arrives.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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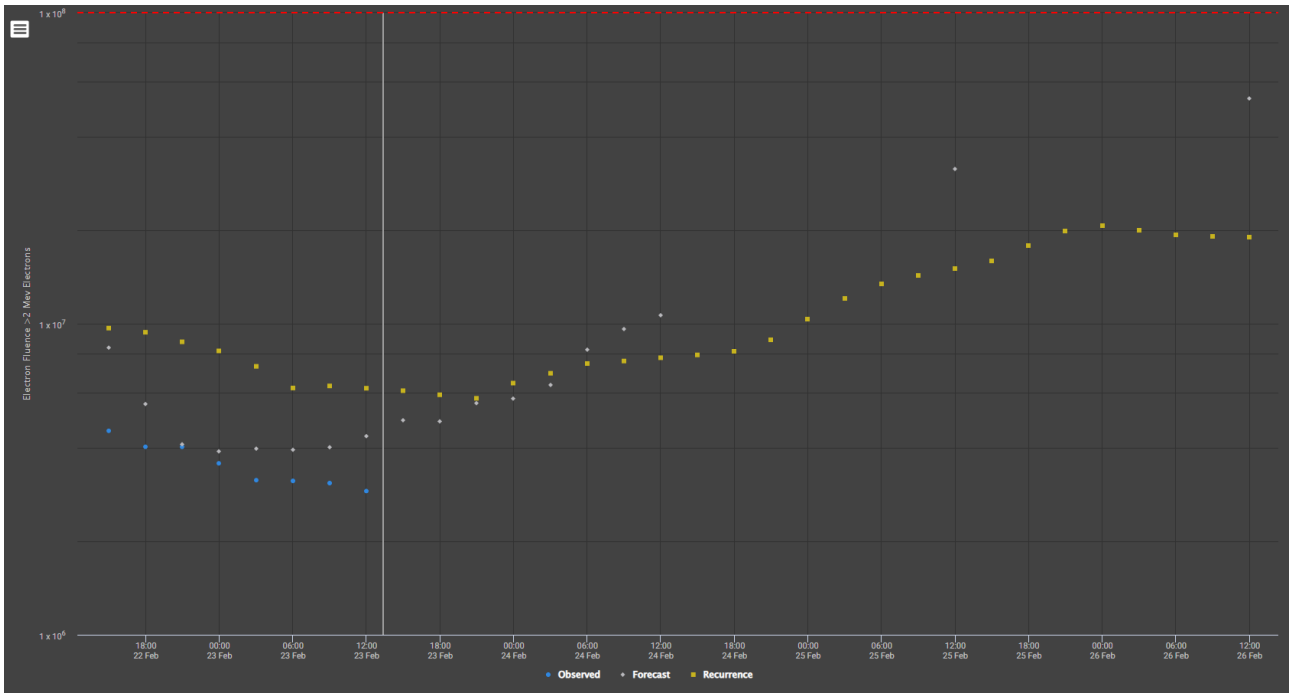
Figure 4: MOSWOC REFM integrated flux/fluence.



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